Summary: Dagstuhl Seminar Geometric Modeling 2008

Organizers: Gerald Farin (Arizona State University, USA), Stefanie Hahmann
(Inst.Nat.Poly. de Grenoble, France), Jörg Peters (University of Florida,USA),
Wenping Wang (University of Hong Kong, China)

The seminar succeeded in bringing together leading researchers to present and discuss radically different approaches to the challenge of modeling complex geometric phenomena on the computer. Acquisition, representation and analysis of 3-dimensional geometry call for the combination of technically complex and often interdisciplinary approaches that are grounded both in classical mathematics and computer science data structures and theory. Reflecting the dynamics of the field, the meeting included a number of junior researchers.

The presentations ranged from the application of graphics processing units, to graph techniques, to algebraic approaches, discrete geometry, combining clasical spline with new subdivision methods and leveraging the geometry of classical surfaces in areas as far as architecture and medical modeling.

The unique setting and combination of participants revealed and correlated a surprising number of new techniques and insights. New surface fitting methods addressed the intricate problem of resolving the shape where several different primary geometric features merge (the multisided fair surface blending problem), and of representing thicker layers of surfaces (shells) as well as support functions on surfaces to support computations on manifolds. A key point, both for industrial applications and fundamental scientific inquiery, is the topological correctness of surfaces. In particular, topological and metric guarantees are needed when reconstructing and matching objects or extracting surfaces (geometric processing); for example to avoid singularities and self-intersections. Consistency leads to a reexamination and extension of difference (discrete) geometry. The need for interpreting and modifying existing geometry also motivates the search for finding parameterizations, both globally and via partition of space, The (highly nonlinear) challenge of not only measuring but of controlling intrinsic geometry was laid out in several talks. While some approaches concentrate on the mathematical challenge, an alternative is to emphasize the interface and human intervention. For simple geometry, determining geometry from constraints is another viable approach. Subdivision is an intriguing technique to flexibly represent geometry via refinement. This method bridges discrete and spline-based geometry. While key components have matured to the point where a survey talk laid out the fundamental structure, talks exposing work in progress and posing unresolved questions highlighted the need for further work. The detailed findings will appear in two refereed volumes, of full length research papers on Geometric Modeling to be published in a Springer journal.

Fittingly, the workshop was the setting for the *John Gregory* Award. The award, named after a pioneer of the field, honored the longterm innovative contributions to field of Hartmut Prautzsch, Helmut Pottmann and Tom Sederberg.

The productive meeting and exchange was made possible thanks to the unique setting and atmosphere of Dagstuhl castle whose scientific board gave the opportunity to

organize this seminar and whose excellent administration made it possible to focus on work.

List of Participants

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List of Talks

Monday	Session chair/speaker	topic
9:00-10:30	Gerald Farin	90 sec introductions
11:00-12:30	Craig Gotsman	
	Kerstin Müller, TU Braunschweig	PNG1 Triangles
	Scott Schaefer, Texas A+M	Manifold Dual Contouring
	Johannes Wallner, TU Graz	Discrete differential geometry of hexagonal meshes
14:00-15:30	S. Hahmann	
	Ahmad Nasri, Amer U Beirut	Skinning T-spline Surfaces
	Jens Gravesen, TU Denmark	The geometry of the Moineau pump
	Tao Ju, Washington U	Surface reconstruction from cross-section curves
16:00-17:30	Jörg Peters	*Subdivision*
	Ron Goldman, Rice University	An Analogue of the Lane-Riesenfeld Subdivision Algorithm for B-splines with Non-Uniform Knots
	Kai Hormann, TU Clausthal	Designing Subdivision Schemes with High Approximation Orders
	Georg Umlauf, TU Kaiserslautern	Symmetry of shape charts with applications to energy-minimizing subdivision algorithms

Tuesday	Session chair/speaker	topic
9:00-10:30	Hiromasa Suzuki	*Surface Fitting*
	Takashi Maekawa, Yokohama N U	Fitting Curves and Surfaces by Geometric Algorithms
	Shi-Min Hu, Tsinghua U Beijing	Fairing Wireframes in Industrial Surface Design
	Marc Alexa, TU Berlin	Hermite Point Set Surfaces
10:45-12:15	Tao Ju	*Surfaces & interpolation*
	Stefanie Hahmann, LMC-IMAG, Grenoble	Interpolation of Irregular Meshes with Bicubic G1 Bezier Surfaces
	Tae-Wan Kim, Seoul National University	Approximation of Implicit Surfaces by Local and Singularity Free G1 Triangular Spline Surfaces
	Kestutis Karciauskas, Vilnius University	Low Degree Curvature Continuous Multisided Surfaces
14:00-15:30	Thomas Grandine	*Interpolation & reconstruction*
	Stephen Mann, University of Waterloo	Hermite Polynomial Least Interpolation
	Larry Schumaker, Vanderbilt U	Scattered Data Fitting on Manifolds
	Gregory Nielson, ASU – Tempe	Adaptive, Implicit Modeling of Urban Terrain Noisy Point Cloud Data
16:00-17:30	Bert Juettler	*Guaranteed Geometry*
	Falai Chen, U S T of China	Computing Sigularities of Rational Ruled Surfaces
	Gershon Elber, Technion – Haifa	Surface Self-Intersection Computation via Algebraic Decomposition
	Bernard Mourrain, INRIA - SophAnt	Subdivision Methods for Geometric Processing of Semi-algebraic sets

Wednesday	Session chair/speaker	topic
9:00-10:30	Kai Hormann	*Meshes*
	Martin Hering-Bertram, TU Kaiserslautern	Geometric Data Representations for Simulation and Visualization
	Craig Gotsman, Technion – Haifa	A Global/Local Approach to 3D Mesh Parameterization
	Konrad Polthier, FU Berlin	Mesh Parameterization
10:45-12:15	Bernard Mourrain	*Geometric Processing*
	Thomas J. Peters, U Conn – Storrs	Topology During Approximation of Manifolds
	Guido Brunnett, TU Chemnitz	Skeletonization on the bcc lattice
	Pere Brunet, TU of Catalonia – Barcelona	Massive mesh hole repair minimizing user intervention

Thursday	Session chair/speaker	topic
9:00-10:50	Johannes Wallner	*Subdivision*
	Victoria Hernandez-Mederos, ICIMAF - La Habana	Curve subdivision with control of the arc-length
	Ulrich Reif, TU Darmstadt	Analysis and Construction of Subdivision Algorithms
	Tom Cashman, U Cambridge	Towards NURBS – Compatible Subdivision
	Malcolm A. Sabin, Num Geom Ltd.	Two Problems in Subdivision
11:05-12:15	Marc Alexa	*Parameterization*
	Alexander Belyaev, Heriot-Watt U, Edinburgh	Angle-based Harmonic Interpolation
	Yaron Lipman, Tel Aviv U	Green Coordinates
14:00 – 15:30	Georg Umlauf	*Meshes*
	Hiromasa Suzuki, U of Tokyo	Fragment based Mesh Segmentation for Reverse Engineering
	Jonathan Shewchuk, U C Berkeley	Isosurface Stuffing: Fast Tetrahedral Meshes with Good Dihedral Angles
	Wenping Wang, U of Hong Kong	Centroidal Voronoi Tessellation
16:00-17:30	Thomas Peters	*Geometric Constraints*
	Thomas Grandine, Boeing, Seattle	Solid Modeling Applications of the Assignment Problem
	Jörg Peters, U of Florida	Partial Elimination in Constraint Solving
	Bert Jüttler, U of Linz	Geometric Computing with Arcs and Biarcs

Friday	Session chair/speaker	topic
9:00-10:30	Pere Brunet	*Surface modeling & Processing*
	Helmut Pottmann, TU Wien	Curved Folding
	Nikolaos S. Sapidis, U Aegean	A New Method for Sketching a Solid Model in a CAD System
	Rich Riesenfeld, U of Utah	Dynamic Geometric Computation of Interacting Models
10:45-12:15	Scott Schaefer	*Curves*
	Jianmin Zheng, NTU – Singapore	C^1 homogeneous representation of G^1 composite rational Bezier curves
	Panagiotis Kaklis, NTU – Athens	Controlling torsion sign
	Gudrun Albrecht, U of Valenciennes	Planar rational quadratics and cubics: parametrization and shape control